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***A STUDY OF THE MUSCULAR TUNIC OF THE
LARGE AND SMALL INTESTINES OF MAN
IN THE VICINITY OF THE CÆCUM.***

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PREFACE.

A few years ago, in connection with work done on a comparison of the cæcum of man and some other mammals, I was surprised at the variations in the descriptions of the muscular tunic of the intestines of man, as given by different anatomists. There seemed to be need of further study to determine the anatomical structure and relations of this tunic. In this thesis, I give the result of such study as I have been able to make of this subject in the time at my command.

In making this study, the portions of the intestines taken for examination were the caudal or terminal portion of the ileum, the cæcum, the appendix and the beginning of the ascending colon. This part of the intestinal tract was studied in specimens taken from three infants, and in specimens taken from five adults and prepared by maceration. The course and relation of the muscular layers was traced by dissection under a simple microscope.

The arrangement and relations of the muscular layers varied not only on different specimens, but on different aspects of the same specimen, so that a typical arrangement could not be determined from the examination of a small number.

Even with the most careful dissection, it was sometimes impossible to be absolutely sure that the true relation of certain muscular fibres was what it appeared to be. In such cases, serial sections should be made and studied under higher powers to confirm the observations already made or to correct possible error. This, I have been unable to do, yet some new and interesting facts have been determined.

HISTORICAL RESUMÉ.

Anatomists, in their descriptions of the muscular tunic of the intestines of man, generally agree in the following points: It is composed of two layers, an ectal longitudinal and an ental circular layer. In the small intestine, both layers cover its entire circumference, while in the large intestine, the longitudinal layer is gathered entirely, or for the most part, into three bands termed *ligamenti coli*. The large intestine is sacculated because the longitudinal bands are shorter than the other layers of the intestinal wall, so that if these bands be cut transversely or removed, the sacculi are smoothed out to form a cylindrical wall. The longitudinal layer is thinner than the circular layer on the small intestine, but on the cæcum and colon the circular layer is thinner than the longitudinal bands. The circular layer on the colon and cæcum is considerably thicker in the intervals between the sacculi than over the sacculi.

Concerning the small intestine, Kolliker says that the fibres of the longitudinal layer of the small intestine "Do not form a complete layer since they are very scanty or even entirely absent on the mesenteric border." Gray and Sappig agree with Kolliker that the longitudinal layer is thicker on its free than on its attached border, but believe that it does form a complete layer. They also state that the muscular coat grows thinner as it approaches the large intestine.

Verson says, "In its further course the muscular layer presents nothing remarkable until it reaches the *valvuli coli*. Throughout this, as is particularly observable in the new-born child, only the circular layer passes, while the longitudinal layer is interrupted; and, indeed, the bands of the latter, proceeding on the one hand from the ileum and on the other hand from the colon become considerably attenuated toward the free border of the valve, while many muscular fasciculi interlace with each other, and finally, as my preparations show, arch toward the adjoining circular layer."

Gray states that "The longitudinal fibres and peritonæum are continued uninterruptedly across from one intestine to the other," the ileo-cæcal valve being formed by a reduplication of the mucous membrane and the circular layers. Henle agrees with Gray and traces the course of the fibres a little further. He says: "While

the circular layer of the small intestine passes over into the valvuli coli, the longitudinal fibres project themselves in large passing-over bundles, part in elastic tendons, into the whole circumference of the point of insertion on the side of the large intestine, part losing themselves between and part upon the circular fibres."

Allen offers still another opinion. He believes that "The longitudinal coat of the ileum is continuous with that of the cæcum."

With regard to the arrangement of the layers of the muscular coat of the large intestine also, anatomists differ. "The fibres of the longitudinal layer," says Leidy, "Are for the most part collected into three bands about a third of an inch wide, which start from the base of the vermiform appendix and thence extend nearly equidistant from one another along the colon to its termination, where they widen and become a continuous layer on the rectum. From the commencement of the bands the longitudinal fibres are also extended as a continuous layer of the vermiform appendix. In the intervals of the bands on the colon, the wall is provided with a very thin layer of longitudinal fibres."

Meckel says, "One of these bands is situated posteriorly and corresponds to the point where the intestine is kept in place by the peritoneum; the second is anterior and proceeds in the middle portion below the insertion of the epiloön; the third, occupies the inside of the ascending and the descending and the lower side of the transverse portion where it is perfectly loose. We also find at intervals between these three bands several distinct fasciculi of longitudinal fibres, and in subjects where the muscular system is very much developed the large intestine is entirely surrounded by a layer of these fibres, always arranged, however, so that the intermediate fibres are much weaker than the three bands."

Piersol says, "The longitudinal layer is incomplete, its fibres being collected into three flat bands, ten to fifteen millimeters wide. These longitudinal bands are much shorter than the other layers of the intestinal wall, which arrangement results in the characteristic saculation of the large intestine."

Krause says, "The longitudinal layer of both intestines likewise pass over into each other."

Of the circular layer, Gray says, "The circular fibres form a thin layer over the cæcum and colon, being especially accumulated in the intervals between the sacculi."

Krause gives a different description, as follows: "The circular muscle is uniformly thick as far as the lower end of the large intestine. It forms in common with that of the small intestine the annular arrangement of muscle fibres of the *valvula coli*."

My own study, the result of which I will now give in detail, leads me to believe that all of these varying conditions of structure and arrangement may have been found by different observers, but that these descriptions are based on the examination of an insufficient number of specimens.

In specimen number I, the longitudinal layer of the small intestine attenuates as it approaches the large intestine, and is thicker on the attached than on the free border. The last fifteen or twenty millimeters of the right lateral surface of the ileum is closely united to the left lateral surface of the cæcum. About twenty millimeters from the ileo-cæcal valve the longitudinal layer on the right lateral surface of the ileum begins to attenuate rapidly, so that over the ten millimeters nearest the valve this layer is deficient, the circular layer of the left lateral surface of the cæcum and the circular layer of the right lateral surface of the ileum being separated only by connective tissue.

Most of the longitudinal fibres on the left lateral surface of the ileum pass uninterruptedly onto the large intestine, and either lose themselves upon or between the fibres of the left lateral longitudinal band of the colon, or are continuous with them. (Plate 1, A.) The rest of the longitudinal fibres on the left lateral surface of the ileum, and the longitudinal fibres on its dorsal and ventral surfaces pass onto the large intestine and lose themselves upon or between the fibres of the circular layer, or are continuous with them. (Plate 1, R.)

The circular layer of the ileum also attenuates as it approaches the *valvula coli*, into which, some of its fibres pass.

The longitudinal layer of the colon is almost entirely collected into three bands, one on the left lateral surface, one on the right lateral surface, and one on the dorsal surface of the ascending portion. These bands differ in width, the right lateral and dorsal bands being eight millimeters wide while the left lateral band is only five millimeters wide.

On the cæcum there are only two longitudinal bands, the right lateral and the dorsal, the left lateral band being deficient; but

the entire surface of the cæcum is covered with a longitudinal muscular layer, thicker than that of the small intestines. (Plate 1, C.) The fibres of that portion of the longitudinal layer of the cæcum between the bands are continued upon the appendix. (Plate 1, D.)

The fibres of the dorsal and right lateral bands in part, pass onto the appendix, being continuous with its longitudinal fibres and part arch across the end of the cæcum so that fibres of the two bands are continuous. (Plate 2.)

Some of the fibres of the left lateral band of the colon pass onto the ileum and, either lose themselves upon or between the longitudinal fibres of the left lateral surface of the ileum, or are continuous with them. (Plate 1, A.) Part of them continue on the colon toward the ileo-cæcal valve, attenuating and disappearing before they reach the valve. None of the fibres of the left lateral band pass onto the cæcum, which has, therefore, as before stated, but two longitudinal bands.

The circular layer of the large intestine is continuous throughout its entire circumference, and, together with the other layers of the intestinal wall, except the longitudinal layer, is sacculated. The circular layer is thicker in the depressions between the sacculi than upon the sacculi. The sacculations lie entirely between the longitudinal bands, in no instance passing underneath them.

Specimen number II : The layers of the muscular tunic on this specimen are thinner than those on number 1. The longitudinal layer of the ileum attenuates as it approaches the large intestine.

On the right lateral surface of the ileum, the longitudinal fibres, instead of becoming entirely deficient, about ten or fifteen millimeters from the ileo-cæcal valve, as in specimen number 1, pass onto the cæcum and, either lose themselves on or between the fibres of the circular layer, or are continuous with them.

On the left lateral surface of the ileum the longitudinal layer attenuates as it approaches the ileo-cæcal valve, so that it is deficient in streaks. A few of the fibres on this surface pass onto the colon, where they either lose themselves on or between the fibres of the left lateral band, or become continuous with them. The rest of the longitudinal fibres on this surface and those on the ventral and dorsal surfaces pass onto the large intestine and,

either lose themselves on or between the fibres of the circular layer, or become continuous with them. (Plate 1, A.)

The arrangement of the circular layer of the ileum is the same as in specimen number one, except that some of its fibres on the ventral surface, two or three millimeters from the ileo-cæcal valve, pass onto the ventral surface of the cæcum and, either lose themselves on or between the fibres of the circular layer of the cæcum, or are continuous with them. (Plate 4.)

The longitudinal muscular layer of the large intestine in this specimen is collected almost entirely into the three longitudinal bands, being either deficient or extremely thin between the bands. The left lateral band is about one-third as wide as, and much thinner than the other two bands. Most of the fibres of this band begin to attenuate rapidly about ten millimeters from the ileo-cæcal valve, and become deficient without entering into the valve. A few of the fibres of this band pass onto the left lateral surface of the ileum and, either lose themselves upon or between, or become continuous with the fibres of the longitudinal layers of the ileum. (Plate 3, N.) Another part of the fibres of this left lateral band is deflected a little ventrad, around the insertion of the ileum, and passes along the cæcum to form a narrow left lateral band, about one and one-half millimeters wide. Some of the fibres of this band on the cæcum pass onto the appendix, while some either lose themselves upon or between, or become continuous with the fibres of the right lateral band. (Plate 3, G, F.)

Part of the fibres of the right lateral band pass onto the appendix. (Plate 3, M.) Part pass dorsad to become continuous with, or lost upon or between the fibres of the dorsal band. (Plate 3, P.) Part pass ventrad to become continuous with, or lost upon or between the fibres of the left lateral band. (Plate 3, F.) Part pass ventrad, and turning, become continuous with, or lost upon or between the fibres of the circular layer.

The circular layer on the large intestine is very thin, even deficient in narrow streaks, so that, in some places, the sub-mucous layer is next to the serous layer of the intestinal wall. (Exhibit A.) Some of the fibres of the circular layer, near the insertion of the ileum, pass onto the left lateral surface of the ileum and, either become continuous with, or are lost upon or

between the fibres of the circular layer of that surface of the ileum. (Plate 4.)

Around the insertion of the ileum into the large intestine, and lying on the cæcum and colon, except on a portion of the left lateral surface of the cæcum, where it passes onto the right lateral surface of the ileum, is a thick circular band of muscular fibres varying in width from five to ten millimeters. (Plate 5, D. Exhibit A.) Some of the fibres which form this band pass into the band from depressions between the sacculi on the ventral surface of the large intestine and some from one of the depressions between the sacculi on the dorsal surface of the large intestine. (Plate 5, R. B. Exhibit A.)

Specimen Number III: The muscular tunic of both the large and the small intestine in this specimen is very thin. The longitudinal layer on the left lateral surface of the ileum attenuates and disappears about two millimeters from the ileo-cæcal valve so that, on this surface for a space of about two millimeters the circular layer and the serous layer are in apposition. Otherwise the longitudinal layer does not differ from that of specimen number II.

The dorsal and right lateral bands on the large intestine are each nine millimeters wide, the left lateral band being three millimeters wide. The cæcum, as in specimen number I, has a complete and continuous longitudinal layer. (Plate 1, C.) Most of the fibres of the dorsal and right lateral bands pass on to the appendix, but some fibres pass from one band to the other as in specimen number II.

None of the fibres of the left lateral band pass onto the cæcum, but they attenuate and disappear on the colon as they approach the ileo-cæcal valve. This cæcum, also, then, has only two longitudinal bands, a dorsal and a right lateral.

Some of the circular layers on the ventral surface of the cæcum, near the insertion of the ileum, appear to pass onto the ileum underneath its circular layer and to terminate in the sub-mucosa of the ileum.

The band of fibres found around the insertion of the ileum into the large intestine in specimen number II was also present in this specimen. (Plate 5, D. Exhibit B.)

Specimen number IV: The arrangement and relation of the

longitudinal layer on the right lateral, dorsal, and ventral surfaces of the ileum is essentially the same as in specimen number II. The fibres of the longitudinal layer on the left lateral surface pass onto the colon, and, either lose themselves upon or between, or become continuous with the fibres of the left lateral band or with the fibres of the circular layer of the large intestine.

The longitudinal bands on the large intestine were narrow and thick as compared with the bands on the other specimens. The right lateral and dorsal bands were each five millimeters wide and the left lateral band four millimeters wide. The cæcum between the longitudinal bands had a complete longitudinal muscular layer, the fibres of which, caudad, are either lost upon or between the longitudinal fibres of the appendix or are continuous with them, and, ventrad, attenuate rapidly as they pass from the cæcum to the colon, either entirely disappearing or forming an extremely thin layer.

Most of the fibres of the three longitudinal bands of the large intestine are either lost upon or between or are continuous with the longitudinal fibres of the appendix. But part of the fibres of the left lateral band pass onto the ileum where they lose themselves upon or between the longitudinal fibres of the left lateral surface of the ileum, or are continuous with them; part are lost upon or between or are continuous with the fibres of the dorsal band; and part are lost upon or between or are continuous with the fibres of the right lateral band.

Some circular fibres from the left lateral surface of the large intestine pass onto the ileum, where they lose themselves either upon or between, or are continuous with the circular layer of the ileum. (Plate 4.) This specimen also had the circular band of muscular fibres to strengthen the insertion of the ileum into the large intestine. (Plate 5, D.)

Specimen number V: In this specimen most of the dorsal surface of the small intestine was firmly united to the ventral surface of the cæcum by connective tissue. On this part of the dorsal surface of the ileum in contact with the cæcum, the longitudinal muscular layer was deficient, while on either side of this part was a ridge of muscular fibres formed by a thickening of the longitudinal muscular layer, and by the deviation of some of those fibres, which if continued on the small intestine in a straight line would

have covered that portion of the dorsal surface of the ileum where the longitudinal layer was deficient. One of these ridges was on the right lateral surface, and the other on the dorsal surface of the ileum.

The fibres of the ridge on the right lateral surface of the ileum pass onto the cæcum, and either lose themselves upon or between, or become continuous with the fibres of the circular muscular layer of the cæcum.

The fibres of the ridge on the dorsal surface of the ileum are variously distributed as they pass onto the cæcum. Part of the more superficial fibres form a longitudinal layer on the rounded, caudal end of the cæcum, and either lose themselves upon or between, or are continuous with the fibres of the longitudinal layer of the appendix; and part lose themselves upon or between, or are continuous with the fibres of the right lateral, longitudinal band on the cæcum; and part, passing over the end of the cæcum around the insertion of the appendix, either lose themselves upon or between, or become continuous with the fibres of the dorsal, longitudinal band on the large intestine. Part of the deeper layer of fibres of this dorsal ridge, so mingled with the circular layer of the ventral surface of the cæcum, that the two layers could not be separated. The rest of the fibres of the deeper layer of the dorsal ridge mingle in the same inseparable manner with the ring of muscular tissue which surrounds the insertion of the ileum into the cæcum, this ring being present on this specimen.

The fibres of the longitudinal layer on the left lateral surface of the ileum pass uninterruptedly onto the large intestine; part lose themselves upon or between, or become continuous with the circular, muscular layer of the large intestine and part lose themselves upon or between, or are continuous with the fibres of the left lateral band.

The fibres of the longitudinal layer of the ileum, not already described, either lose themselves upon or between, or become continuous with the fibres of the circular layer of the large intestine.

The breadth of the longitudinal band of the large intestine in this specimen were, right lateral, eight millimeters; left lateral, eight millimeters; dorsal, five millimeters, the dorsal band in this case being the narrowest.

Part of the fibres of the left lateral band of the large intestine

pass onto the small intestine and either lose themselves upon or between, or become continuous with the fibres of the longitudinal, muscular layer of the left lateral surface of the ileum ; part pass onto the appendix and part curve across the cæcum at the proximal end of the appendix to mingle with the fibres of the right lateral band ; still another part curve across the cæcum at the proximal end of the appendix and mingle with the fibres of the dorsal band.

Part of the fibres of the right lateral band curve across the cæcum just cephalad of the proximal end of the appendix and either lose themselves upon or between, or become continuous with the fibres of the dorsal band ; part curve across the cæcum just cephalad of the proximal end of the appendix and either lose themselves upon or between, or become continuous with the fibres of the left lateral band ; part pass onto the appendix and either lose themselves upon or between, or become continuous with the longitudinal fibres of the appendix ; part pass onto the small intestine and either lose themselves upon or between, or become continuous with the fibres of the thickened ridge on the dorsal surface of the ileum.

Part of the fibres of the dorsal, longitudinal band curve across the cæcum just cephalad of the proximal end of the appendix and either lose themselves upon or between, or become continuous with the fibres of the right lateral band ; part pass across the end of the cæcum just cephalad of the proximal end of the appendix and either lose themselves upon or between, or become continuous with the fibres of the left lateral band ; part cross over the cæcum just cephalad of the proximal end of the appendix and, passing cephalad with the fibres of the left lateral band for about two centimeters, turn and either lose themselves upon or between, or become continuous with the fibres of the circular layer of the large intestine ; part lose themselves upon or between, or become continuous with the longitudinal fibres of the appendix, and part pass onto the small intestine and either lose themselves upon or between, or become continuous with the fibres of the thickened ridge on the dorsal surface of the ileum.

All writers on the subject, so far as I know, seem to agree to the statement that the large intestine is sacculated because the longitudinal bands are shorter than the other layers of the intes-

tinal wall, so that, if these bands be cut transversely or removed, the sacculi are smoothed out to form a cylindrical wall. To test the accuracy of this statement the following experiments were made. A portion of the large intestine, about seventeen centimeters in length, was tied at one end, filled with water and then tied at the other end. Each longitudinal band was transected in four places, each set of transections being made at the same level, so that a plane passed through any set would be parallel to the transverse diameter of the intestine. This portion of the intestine was then suspended by one end, but the sacculi did not smooth out to form a cylindrical wall. (Exhibit C.)

The longitudinal bands on the specimen shown in Exhibit A were entirely removed and yet the sacculations remained well defined.

In another portion of the intestine filled with water as above, the longitudinal bands were entirely removed. The portion of intestine used increased in length about one third; part of the sacculi entirely disappeared and all of them became much less distinctly defined, but they were not obliterated so that the wall could properly be called a cylindrical wall. It was still slightly sacculated. (Exhibit D.)

From another specimen, everything external to the circular muscular layer was removed. Between some of the bands the wall became perfectly smooth, but between the other bands the sacculi did not entirely disappear.

The result of these experiments indicated that the sacculation of the large intestine did not depend entirely on the shortness of the longitudinal muscular bands, as compared with the other layers of the wall of the intestine, and led to a little further study of the comparative length of the layers of this wall.

If the sacculations were caused by the difference in length of the layers of the wall, we should expect to find the sacculations extending around the entire circumference of the intestine. But it was found that the sacculations did not, anywhere, on any specimen examined, pass underneath the longitudinal bands, but lay wholly between them so that the portion of the different layers of the wall of the intestine underneath the longitudinal bands were not sacculated but were perfectly smooth, and were consequently of the same length as the longitudinal band. (Exhibit C.)

Another indication that the sacculation is not entirely dependent on the difference in length of the layers of the intestinal wall, is the shape and size of some of the sacculations, which occasionally bulge out from the surface like toy balloons. (Exhibit B.)

On the other hand, the marked increase in the length of the intestine on entire removal of the bands indicates that the sacculation may be due largely to a difference in the length of the layers.

I cannot reconcile in my own mind these two facts, that the longitudinal bands and the portions of the other layers underneath them are of the same length, and that when the bands are entirely removed the intestine increases so much in length. But I am satisfied that the sacculation is not entirely caused by a difference in length of the layers of the intestinal wall.

In connection with this question of succulation there is another interesting fact referred to, I think, by only two writers. Gegenbauer says: "The muscular membrane of the large intestine in the early development is, like the former, (the small intestine), composed of an outer longitudinal and an inner circular layer, both continuous. Gradually, as the cæcum grows, a change takes place, the longitudinal layer no longer forms a continuous layer, but arranges itself in three bands." Marshall, in his work on vertebrate embryology says: "The large intestine is at first closely similar to the small intestine."

A specimen taken from a six and one-half months fœtus shows both the bands and the sacculations of the large intestine. The similarity spoken of by Gegenbauer and by Marshall is probably, therefore, at an earlier period of fœtal life. (Exhibit E.)

The longitudinal band, which is the left lateral band on the cæcum and the ascending colon, the caudal band on the transverse colon, and the right lateral band on the descending colon, is shorter than the other two bands. For, in any curved tube the wall which is nearer the center of the curve is shorter than the wall farther from the center of the curve.

SUMMARY.

We would summarize the result of this study as follows: In different specimens there is much variation in the thickness, arrangement, and relations of the muscular tunic. The variation

in thickness is most noticeable on the large intestine, where, in some specimens, both layers are so thin as to be deficient in some places, while in other specimens both layers are well developed.

The fibres of the longitudinal, muscular layer on the left lateral surface of the ileum, either attenuate and disappear, or pass uninterruptedly onto the large intestine, where they either lose themselves upon or between, or become continuous with the fibres of the left longitudinal band of the colon, or with the fibres of the circular muscular layer of the colon.

The fibres of the longitudinal muscular layer on the right lateral surface of the ileum, either attenuate and disappear, or pass uninterruptedly onto the large intestine, where they lose themselves upon or between, or become continuous with the fibres of the circular layer of the large intestine.

With the exception of the fibres on the dorsal surface of the ileum of specimen number V, the longitudinal fibres of the ventral and dorsal surfaces of the ileum pass uninterruptedly onto the large intestine, and either lose themselves upon or between, or become continuous with the fibres of the circular muscular layer of the large intestine.

The circular muscular layer of the ileum attenuates somewhat as it approaches the large intestine and enters into formation of the ileo-cæcal valve.

In three of the specimens none of the muscular fibres of the circular layer of the ileum pass onto the large intestine; but in two of the specimens some of the muscular fibres of the circular layer of the ileum, near its insertion into the large intestine, pass onto the large intestine and either lose themselves upon or between, or become continuous with the fibres of the circular muscular layer of the large intestine.

The longitudinal muscular layer of the cæcum in four of the five specimens formed, like the longitudinal layer of the small intestine, a complete, continuous, well developed investment of that part of the intestine with distinct thickenings to form either two or three longitudinal bands. In two specimens there were only two longitudinal bands on the cæcum, the left lateral band being deficient. In the other three specimens the left longitudinal band on the cæcum was very narrow, only a small part of the fibres of the left lateral band of the colon passing onto the cæcum. In

one specimen, the longitudinal muscular layer between the longitudinal bands on the cæcum was either extremely thin or deficient.

In regard to whether the longitudinal muscular layer of the colon forms a complete, continuous investment, observations were not made, except in one specimen, where it did form such an investment, as far as the descending colon.

Meckel's statement would lead us to believe that the large intestine is entirely surrounded by a complete longitudinal muscular layer, only in those subjects where the muscular system is very much developed. But the four specimens in which the longitudinal layer formed a complete investment of the cæcum, were taken from subjects in which the muscular system was not particularly well developed.

The three well defined longitudinal muscular bands were present on the colon in all specimens. These bands differed in breadth on the same specimen and on different specimens. In four subjects the left lateral was the narrowest band: in one specimen it was one millimeter, in another three millimeters, and in the other two six millimeters narrower than the right lateral and dorsal bands, which were about the same breadth. In one specimen the dorsal band was three millimeters narrower than either the right or left lateral band. The left lateral band was in all specimens longer than the other two bands.

The fibres of the left longitudinal band have the following relations: they may attenuate and disappear on the colon; they may pass uninterruptedly onto the ileum and either lose themselves upon or between, or become continuous with the fibres of the longitudinal muscular layer on the left lateral surface of the ileum; while some may be continued directly onto the appendix, and some may curve around the cæcum just cephalad of the proximal end of the appendix either to lose themselves upon or between, or become continuous with the fibres of the other longitudinal bands. In two specimens the left lateral band was deficient on the cæcum.

On four of the specimens, the fibres of the right lateral and dorsal bands terminate as follows: Some of the fibres continue directly onto the appendix, some arch across the end of the cæcum just cephalad of the proximal end of the appendix, and either

lose themselves upon or between, or become continuous with the fibres of the other two bands; some turn, and either lose themselves upon or between, or become continuous with the circular fibres of the large intestine. (Exhibit A.) In one specimen, some fibres from the dorsal and right lateral bands pass uninterruptedly onto the ileum, and either lose themselves upon or between, or become continuous with the thickened ridge of fibres on the dorsal surface of the ileum.

In all of the specimens, the circular muscular layer of the large intestine was thicker in the intervals between the sacculi than upon them. In two of the specimens, some of the fibres of the circular muscular layer of the large intestine pass onto the ileum, and either lose themselves upon or between, or become continuous with the fibres of the circular muscular layer of the ileum. In one specimen, some of the fibres of the circular muscular layer on the ventral surface of the cæcum appear to pass onto the ileum, underneath its circular muscular layer and terminate in the submucosa of the ileum.

On four of the five specimens, at the insertion of the ileum into the large intestine, was a thick band of muscular fibre, five to ten millimeters wide, which seemed to serve the purpose of strengthening the insertion of the ileum into the large intestine. So far as I know this band has never before been described. In the other specimen it may have been present and overlooked.

The sacculi of the large intestine lie entirely between the three longitudinal bands and do not continue underneath them, so that those portions of the layers of the wall of the large intestine underneath the longitudinal bands must be of the same length as the longitudinal bands. From the experiments made it appears that this sacculation of the large intestine can not be entirely accounted for, as is usually done by anatomists, by a difference in length between the longitudinal muscular bands, and the other layers of the wall of the large intestine.

The sacculation of the large intestine and the thickening of its longitudinal muscular layer to form the three longitudinal bands are seen in foetal life as early as the twenty-sixth week.

In this thesis, another step has been taken toward the determination of the typical structure and relations of the muscular tunic of the intestine of man, but the examination of a much larger

number of specimens is needed to fully establish the type or types of structure, relation, and arrangement of this tunic.

METHODS.

The arrangements and relations of the fibres of the muscular tunic of the intestines were determined by dissection under a simple microscope.

Specimens were prepared for dissection as follows: The contents of the intestines were evacuated and the interior washed out with 50 per cent. alcohol. The specimens were then placed in 55 per cent. alcohol, to which $\frac{1}{10}$ per cent. picric acid had been added, where they were allowed to remain indefinitely. They were next filled with 50 per cent. alcohol and placed in 20 per cent. nitric acid, where they were left till the fibres could be easily separated. This took from twenty-four to seventy-two hours, depending on the temperature. Nitric acid acts more rapidly in high than in low temperatures.

When the maceration was completed, to prevent further action of the acid and to preserve the specimens, they were placed in a saturated, aqueous solution of alum, to which 2 per cent. of chloral hydrate had been added, to prevent the formation of mold. Specimens treated in this manner kept in good condition for five months.

In making the drawings the serous coat was ignored.

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DESCRIPTION OF PLATE I.

- A.—Fibres of left lateral longitudinal band of colon passing onto the ileum.
- C.—Cæcum.
- D.—Fibres of a longitudinal layer of the vermiform appendix passing onto the cæcum.
- I.—Ileum.
- K.—Colon.
- L.B.—Left lateral longitudinal band on large intestine.
- R.—Fibres of the longitudinal layer on the left lateral surface of the ileum losing themselves upon or between, or becoming continuous with the fibres of the circular layer of the large intestine.
- R.B.—Right lateral longitudinal band on the large intestine.

DESCRIPTION OF PLATE II.

- A.—Appendix.
- C.—Cæcum.
- D.B.—Dorsal, longitudinal band on cæcum.
- R.B.—Right lateral longitudinal band on cæcum.

DESCRIPTION OF PLATE III.

- A.—Appendix.
- C.—Cæcum.
- D.B.—Dorsal longitudinal band.
- F.—Fibres of the right longitudinal band of the cæcum losing themselves upon or between, or becoming continuous with the fibres of the left lateral band of the cæcum.
- G.—Fibres of the left lateral band curving around the insertion of the ileum into the large intestine to mingle with fibres of right lateral band and with longitudinal fibres of the appendix.
- I.—Ileum.
- K.—Colon.

- L. B.—Left lateral longitudinal band.
- M.—Fibres of right lateral longitudinal band of cæcum passing onto vermiform appendix.
- N.—Fibres of left lateral band passing onto ileum.
- P.—Fibres of right lateral band passing dorsad to mingle with fibres of dorsal band.
- R.—Fibres of left lateral band passing onto appendix.
- S.—Fibres of dorsal band passing onto appendix.

DESCRIPTION OF PLATE IV.

- A.—Appendix.
- C.—Cæcum.
- K.—Colon.
- I.—Ileum.
- L. B.—Left lateral band.
- R. B.—Right lateral band.

DESCRIPTION OF PLATE V.

- A.—Appendix.
- C.—Cæcum.
- B.—Circular fibres of the large intestine passing to help form the circular muscular band which strengthens the insertion of the ileum into the large intestine.
- D.—The circular muscular band which strengthens the insertion of the ileum into the large intestine.
- I.—Ileum.
- K.—Colon.
- L. B.—Left lateral band.
- R. B.—Right lateral band.
- R.—Same as B.





